

WHAT IS CLAIMED IS:

1. A catalyst for trimerization of ethylene which comprises:

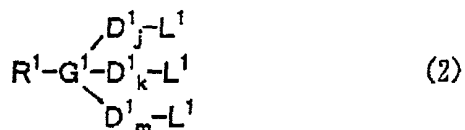
(i) an organometallic complex having a neutral multidentate ligand having a tripod structure, represented by the following formula (1):



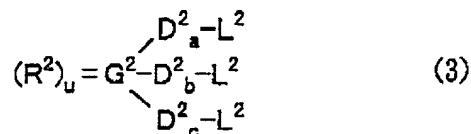
wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M, and

(ii) an alkylaluminoxane;

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

2. A catalyst for trimerization of ethylene which comprises:

(i) an organometallic complex having a neutral multidentate ligand having a tripod structure, represented by the following formula (1):

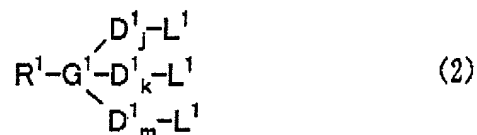


wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M, and

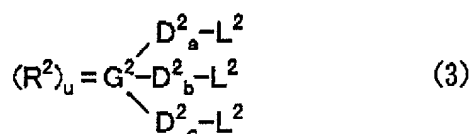
(ii) an alkylaluminumoxane, and

(iii) a halogenated inorganic compound;

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

3. A catalyst for trimerization of ethylene which comprises:

(1) an organometallic complex having a neutral multidentate ligand having a tripod structure, represented by the following formula (1):



wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M,

(ii) an alkylaluminumoxane,

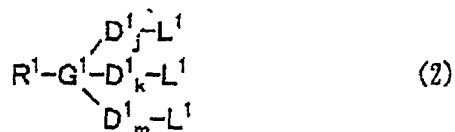
(iii) a halogenated inorganic compound, and

(iv) an alkyl group-containing compound represented by the following formula (4):



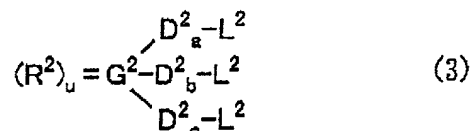
wherein p and q are numbers satisfying the formulae: $0 < p \leq 3$ and $0 \leq q < 3$, provided that (P + q) is in the range of 1 to 3, E represents an atom, other than a hydrogen atom, of group 1, 2, 3, 11, 12 or 13 of the periodic table, each R independently represents an alkyl group having 1 to 10 carbon atoms, and each J independently represents a hydrogen atom, an alkoxide group having 1 to 10 carbon atoms, an aryloxy group having 6 to 10 carbon atoms, an aryl group having 6 to 10 carbon atoms or a halogen atom;

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three

L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

4. A catalyst for trimerization of ethylene which comprises:

(i) an organometallic complex having a neutral multidentate ligand having a tripod structure, represented by the following formula (1):



wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M,

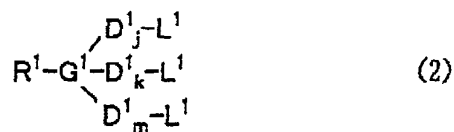
(ii) an alkylaluminumoxane, and

(iii) an alkyl group-containing compound represented by the following formula (4):

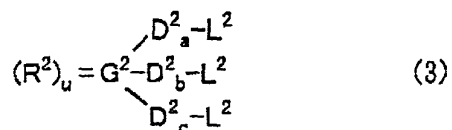


wherein p and q are numbers satisfying the formulae: $0 < p \leq 3$ and $0 \leq q < 3$, provided that (p + q) is in the range of 1 to 3, E represents an atom, other than a hydrogen atom, of group 1, 2, 3, 11, 12 or 13 of the periodic table, each R independently represents an alkyl group having 1 to 10 carbon atoms, and each J independently represents a hydrogen atom, an alkoxide group having 1 to 10 carbon atoms, an aryloxy group having 6 to 10 carbon atoms, an aryl group having 6 to 10 carbon atoms or a halogen atom;

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 s are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to

6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

5. A catalyst for trimerization of ethylene which comprises:

(i) an organometallic complex having a neutral multidentate ligand having a tripod structure, represented by the following formula (1):

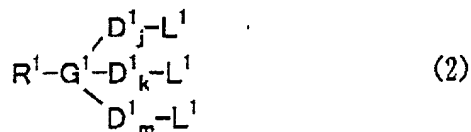


wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M,

(ii) an alkylaluminumoxane, and

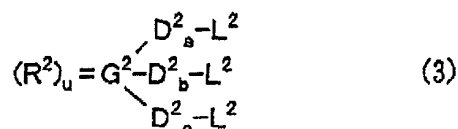
(iii) at least one compound selected from the group consisting of an amine compound and an amide compound;

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to

6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

6. A catalyst for trimerization of ethylene which comprises:

(i) an organometallic complex having a neutral multidentate ligand having a tripod structure, represented by the following formula (1):



wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon

atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M,

(ii) an alkylaluminumoxane,

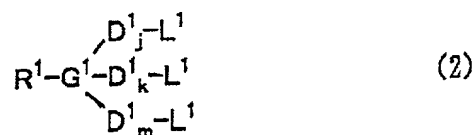
(iii) at least one compound selected from the group consisting of an amine compound and an amide compound, and

(iv) an alkyl group-containing compound represented by the following formula (4):



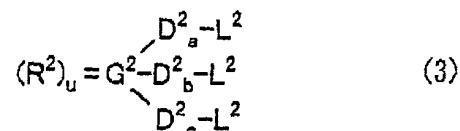
wherein p and q are numbers satisfying the formulae: $0 < p \leq 3$ and $0 \leq q < 3$, provided that (p + q) is in the range of 1 to 3, E represents an atom, other than a hydrogen atom, of group 1, 2, 3, 11, 12 or 13 of the periodic table, each R independently represents an alkyl group having 1 to 10 carbon atoms, and each J independently represents a hydrogen atom, an alkoxide group having 1 to 10 carbon atoms, an aryloxy group having 6 to 10 carbon atoms, an aryl group having 6 to 10 carbon atoms or a halogen atom;

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6

to 10 carbon atoms which may have a substituent;

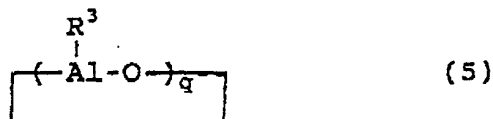


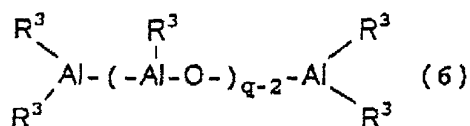
wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 s are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

7. A catalyst for trimerization of ethylene according to any one of claims 1 to 6, wherein said organometallic complex having a neutral multidentate ligand having a tripod structure is an organochromium complex represented by formula (1) wherein M is a chromium atom.

8. A catalyst for trimerization of ethylene according to any one of claims 1 to 6, wherein a neutral multidentate ligand having a tripod structure A is facially coordinated to a transition metal atom M of group 3 to group 10 of the periodic table in the organometallic complex of formula (1).

9. A catalyst for trimerization of ethylene according to any one of claims 1 to 6, the alkylaluminoxane is at least one compound selected from the group consisting of compounds represented by the following formulae (5) and (6):





wherein each R^3 independently represents a hydrogen atom or a hydrocarbon group having 1 to 20 carbon atoms, and q is an integer of 2 to 60.

10. A catalyst for trimerization of ethylene according to claim 2 or 3, the halogenated inorganic compound is represented by the following formula (7):



wherein Z is an atom of group 1, 2, 13, 14 or 15 of the periodic table, X represents a halogen atom, and h denoting a number of X is a natural number equal to the formal oxidation valence of Z .

11. A catalyst for trimerization of ethylene according to claim 5 or 6, wherein each of the amine compound and the amide compound has at least one nitrogen atom having three substituents other than hydrogen atoms, and has 3 to 30 carbon atoms.

12. A process for trimerizing ethylene wherein ethylene is trimerized in the presence of a catalyst as claimed in any one of claims 1 to 6.

13. A process for trimerizing ethylene wherein ethylene is trimerized in the presence of a catalyst as claimed in any one of claims 1 to 6;

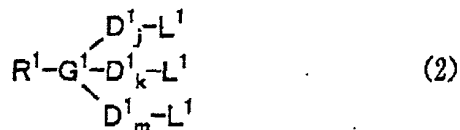
said catalyst being prepared by a step comprising placing (i) an organometallic complex having a neutral multidentate ligand having a tripod structure, in contact with (ii) an alkylaluminumoxane in the presence of ethylene;

said organometallic complex having a neutral multidentate ligand having a tripod structure being represented by the following formula (1):

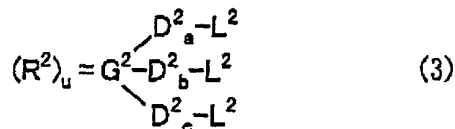


wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M,

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not

concurrently a substituent containing an element an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom.

14. A process for trimerizing ethylene wherein ethylene is trimerized in the presence of a catalyst as claimed in any one of claims 3, 4 and 6;

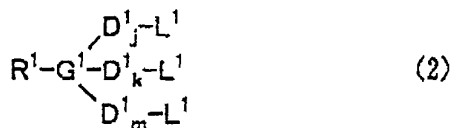
said catalyst being prepared by a step comprising placing (i) an organometallic complex having a neutral multidentate ligand having a tripod structure, in contact with (ii) an alkylaluminumoxane and (iii) an alkyl group-containing compound in the presence of ethylene;

said organometallic complex having a neutral multidentate ligand having a tripod structure (i) being represented by the following formula (1):



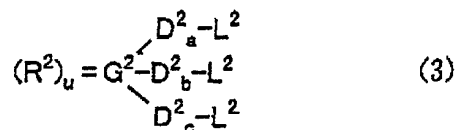
wherein A is a neutral multidentate ligand having a tripod structure, M is a transition metal atom of group 3 to group 10 of the periodic table, each Q is independently selected from the group consisting of a hydrogen atom, a halogen atom, a straight chain or branched alkyl group having 1 to 10 carbon atoms which may have a substituent, an aryl group having 6 to 10 carbon atoms which may have a substituent, and n is an integer equal to a formal oxidation valence of M,

said neutral multidentate ligand A in formula (1) being a tridentate ligand represented by the following formula (2) or formula (3):



wherein j, k and m independently represent an integer of 0 to 6, each D^1 independently represents a divalent hydrocarbon group which may have a substituent, each L^1 independently represents

a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^1 's are not concurrently a substituent containing an element of group 14 or 17, G^1 represents a carbon or silicon atom, and R^1 represents a hydrogen atom, an alkyl group having 1 to 10 carbon atoms which may have a substituent, or an aryl group having 6 to 10 carbon atoms which may have a substituent;



wherein a, b and c independently represent an integer of 0 to 6; u represents an integer of 0 or 1; each D^2 independently represents a divalent hydrocarbon group which may have a substituent; each L^2 independently represents a substituent containing an element of group 14, 15, 16 or 17 of the periodic table, with the proviso that all of the three L^2 's are not concurrently a substituent containing an element of group 14 or 17, G^2 represents a nitrogen or phosphorus atom when u is 0, or a phosphorus atom when u is 1, and R^2 represents an oxygen or sulfur atom; and

said alkyl group-containing compound (iii) being represented by the following formula (4):



wherein p and q are numbers satisfying the formulae: $0 < p \leq 3$ and $0 \leq q < 3$, provided that $(p + q)$ is in the range of 1 to 3, E represents an atom, other than a hydrogen atom, of group 1, 2, 3, 11, 12 or 13 of the periodic table, each R independently represents an alkyl group having 1 to 10 carbon atoms, and each J independently represents a hydrogen atom, an alkoxide group having 1 to 10 carbon atoms, an aryloxy group having 6 to 10 carbon atoms, an aryl group having 6 to 10 carbon atoms or a halogen atom.